Component of Statistics Canada Catalogue no. 82-003-X
Health Reports

Article

An update on cancer survival

by Larry F. Ellison and Kathryn Wilkins

September 2010

Statistics Canada Statistique Canada

Canada

An update on cancer survival

by Larry F. Ellison and Kathryn Wilkins

Abstract

Statistics Canada routinely produces cohort-based estimates for cancer survival, the most recent were based on cases diagnosed from 1992-2000. This report provides predicted survival estimates for cases diagnosed more recently. Using records from the Canadian Cancer Registry linked to the Canadian Vital Statistics Death Data Base, cancer- and age-specific estimates of relative survival have been calculated for 2004-2006. The five-year relative survival ratio (RSR) for all cancers combined was 62%, and ranged from 6% for pancreatic cancer to 98% for cancer of the thyroid. The RSR was typically higher at younger than older ages, with exceptions for some common cancers. From 1992-1994 to 2004-2006, the five-year RSR for a number of cancers increased—usually slightly, but in some cases, appreciably (for example, the age-standardized RSR for non-Hodgkin lymphoma rose from 51% to 63%, for leukemia, from 44% to 54%, and for liver, 9% to 17%).

Keywords

neoplasms, population surveillance, prognosis, registries, survival analysis

Authors

Larry F. Ellison (1-613-951-5244; Larry.Ellison@statcan.gc.ca) is with the Health Statistics Division and Kathryn Wilkins (1-613-951-1769) is with the Health Analysis Division at Statistics Canada, Ottawa, Ontario, K1A 0T6.

A diagnosis of cancer does not usually mean that death is imminent. The five-year survival of Canadians diagnosed with invasive cancer is predicted to be, on average, 62% of that of an otherwise similar group of people without cancer. Of course, the term "cancer" is used to refer to myriad malignancies—each of which confers a distinct illness and prognosis. Some cancers are far more lethal, and within a shorter time-span, than are others.

With records from the Canadian Cancer Registry (CCR) linked to the Canadian Vital Statistics Death Database, relative survival statistics have been calculated. Cohort-based survival estimates from cancer are routinely published by Statistics Canada[1]; the most recent pertained to cases diagnosed from 1992 to 2000. This report provides predicted survival estimates for cases diagnosed in 2004-2006. Duration- and age-specific relative survival estimates are derived for 23 of the most commonly occurring cancers in people aged 15 through 99; five-year survival estimates for cases diagnosed in 2004-2006 are compared with those diagnosed in 1992-1994.

Survival varies by type of cancer

For all cancers combined, the five-year relative survival ratio (RSR) was estimated at 62%—meaning that the predicted probability of surviving five years following a diagnosis of cancer in the years 2004-2006 was about three-fifths the survival probability of persons not diagnosed with cancer (Table 1). The ten-year RSR was nearly as high: 58%. Five-year RSRs ranged from 6% for pancreatic cancer to 98% for cancer of the thyroid. Relative survival was high for cancers of the prostate (96%) and testis (95%), skin melanoma (89%), and breast cancer (88%). Cancer sites for which five-year RSRs were low included esophagus (13%), lung and bronchus (16%), and liver (18%).

With some important exceptions for individual cancers, relative survival exhibited a general pattern of a fairly substantial decline in the year following diagnosis, a somewhat more gradual fall

The data

Cancer incidence data are from the July 2010 version of the Canadian Cancer Registry (CCR), a dynamic, person-oriented, population-based database maintained by Statistics Canada. The CCR contains information on cases diagnosed from 1992 onward, compiled from reports from every provincial/territorial cancer registry.

A file containing records of invasive cancer cases and *in situ* bladder cancer cases (the latter are reported for each province/territory except Ontario) was created using the multiple primary coding rules of the International Agency for Research on Cancer.[2] Cancer cases were classified based on the *International Classification of Diseases for Oncology, Third Edition*[3] and grouped using Surveillance, Epidemiology, and End Results (SEER) Program grouping definitions, with mesothelioma and Kaposi's sarcoma as separate groups.[4]

Mortality follow-up through December 31, 2006 was determined by record linkage to the Canadian Vital Statistics Death Database (excluding deaths registered in the province of Quebec), and from information reported by provincial/territorial cancer registries. For deaths reported by a provincial registry but not confirmed by record linkage, the date of death was assumed to be that submitted by the reporting registry.

Analyses were based on all primary cancers—an approach that is becoming standard practice, as the wisdom of restricting analyses to first primary cancers in an individual has been questioned.[5,6] The effect of including multiple cancers in survival analyses has been studied internationally[5,6] and in Canada.[7] Data from the province of Quebec were excluded from the analysis primarily because of issues in correctly ascertaining the vital status of cases. Records were also excluded if: age at diagnosis was younger than 15 or older than 99; diagnosis was established through autopsy or death certificate; or the year of birth or death was unknown.

Relative survival was estimated.[8] It is defined as the ratio of the observed survival of a group of people with cancer to the expected survival for people in the general population who are assumed to be free of cancer and otherwise have the same characteristics affecting survival as the group with cancer.[8] Survival analyses were based on a publicly available algorithm,[9] to which minor adaptations were made. Expected survival proportions were derived from sex-specific, complete provincial life tables using the Ederer II approach.[10] Further detail on the survival methodology used is provided elsewhere.[1]

The cohort-based method of cancer survival analysis includes only cases diagnosed within defined calendar years and with the potential to be followed over the full duration of interest (for example, five years). Long-term survival estimates derived using the cohort approach may not reflect the long-term survival experience expected for newly diagnosed individuals if the prognosis has changed recently. To address this issue, period analysis was introduced to derive more up-to-date estimates of long-term survival.[11,12] With this method, follow-up data do not relate to a fixed cohort of patients. Rather, estimates are based on the assumption that people diagnosed during the period of interest will experience the most recently observed conditional probabilities of survival. When survival is generally improving, a period estimate tends to be a conservative prediction of the survival that is eventually observed.[13-16]

Period-based survival estimates using CCR data have been published on an ad hoc basis[17-19] and not to the same level of detail as the cohort estimates. Cohort-based survival estimates dating back to cases diagnosed in 1992 are routinely published by Statistics Canada—the latest publication includes cases diagnosed as recently as 2000 and followed to 2005.[1]

For this report, relative survival ratios (RSR) for cases diagnosed in 1992-1994 were derived using the cohort method; predicted RSRs for 2004-2006 were derived using the period method. Age-standardized estimates were calculated using the direct method by weighting age-specific estimates for a given cancer to the age distribution of persons diagnosed with that cancer from 1992-2001.

over the next two years, then a smaller decline over the interval from three to five years after diagnosis. From five to ten years after diagnosis, the decline in survival was typically, but not invariably, small.

In the year after diagnosis, the most lethal cancer was pancreatic, with a one-year RSR of 21%. Other cancers with low one-year RSRs were esophageal (37%), lung and bronchus (39%) and liver (40%). From one to three years after diagnosis, RSRs for multiple myeloma, ovarian and esophageal cancer fell the most steeply of all cancers—each by slightly over 20 percentage points.

In the period from three to five years after diagnosis, the RSRs with the greatest declines were those for multiple myeloma and ovarian cancer, which fell by 13 and 11 percentage points, respectively. From five to ten years after diagnosis, RSRs for most cancers declined by less than 5 percentage points. The most notable exceptions included multiple myeloma and cancer of the larynx, which declined by 15 and 11 percentage points, respectively.

Among cancers with high survival, breast cancer had a relatively large RSR decline of 6 percentage points after five years. For cancers of the prostate, testis and thyroid, the RSR at ten years from diagnosis remained nearly at the same level as at one year (Figure 1).

Survival varies by age

Relative survival differed by age. For most cancers, the RSR was higher at younger than older ages, and for some cancers, the survival advantage at younger ages was quite marked. For example, at ages 15 through 44, the five-year RSR for cancer of the brain was 58%, compared with 9% at ages 65 through 74, and 4% at ages 75 through 99 (Table 2).

For other cancers, when diagnosis occurred before age 75, relative survival

Table 1
Predicted relative survival ratios, by type of cancer and survival duration, population aged 15 to 99 at diagnosis, Canada excluding Quebec, 2004 to 2006

	Survival duration											
	One-year			Three-year			Five-year			Ten-year		
	RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval	
Type of cancer	%	from	to	%	from	to	%	from	to	%	from	to
All cancers	**76**	**76**	**76**	**66**	**66**	**66**	**62**	**62**	**62**	**58**	**58**	**58**
Oral cavity and pharynx	82	81	83	67	66	68	63	61	64	55	54	57
Esophagus	37	36	39	17	15	18	13	12	15	11	10	12
Stomach	47	45	48	28	27	29	24	23	25	22	21	23
Colorectal	81	81	82	69	68	69	63	63	64	61	60	61
Liver	40	38	41	23	22	25	18	16	19	15	13	16
Pancreas	21	21	22	8	8	9	6	6	7	6	5	6
Larynx	85	83	87	71	69	73	64	62	66	53	50	56
Lung and bronchus	39	39	39	20	20	20	16	15	16	12	11	12
Skin melanoma	97	97	97	92	91	92	89	89	90	88	87	89
Breast	97	97	97	91	91	92	88	87	88	82	81	82
Cervix uteri	88	87	89	76	75	78	73	71	74	70	68	71
Corpus uteri	94	93	95	88	87	89	85	85	86	84	83	85
Ovary	74	73	76	53	52	55	42	41	44	35	33	36
Prostate	98	98	99	97	96	97	96	96	97	95	94	96
Testis	98	97	98	96	95	97	95	94	96	95	94	96
Bladder (including *in situ*)	86	85	86	77	76	78	73	72	74	69	67	70
Kidney and renal pelvis	79	78	80	71	70	72	67	66	68	63	62	64
Brain	46	44	47	27	26	28	23	21	24	18	17	19
Thyroid	98	98	99	98	97	98	98	97	98	97	96	98
Hodgkin lymphoma	92	90	93	87	86	89	85	83	87	80	78	82
Non-Hodgkin lymphoma	78	77	79	68	68	69	63	62	64	54	53	55
Multiple myeloma	73	71	74	50	49	52	37	35	38	22	20	24
Leukemias	70	69	71	61	59	62	55	54	56	46	44	47

Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

was similar across the four age groups 15 to 44, 45 to 54, 55 to 64 and 65 to 74, but was lower among people diagnosed between ages 75 and 99. To illustrate, the five-year RSR for colorectal cancer in the four younger age groups ranged from 65% to 68%, but was 58% in the oldest age group. The RSR for breast cancer was 87% to 90% in age groups younger than 75, but 82% among people diagnosed at ages 75 to 99.

Associations between age and survival emerge more clearly when finer age groups are examined. Breast cancer five-year relative survival has been reported elsewhere as 82% when diagnosed before age 40, and prostate cancer, as 82% for men aged 80 to 99.[20]

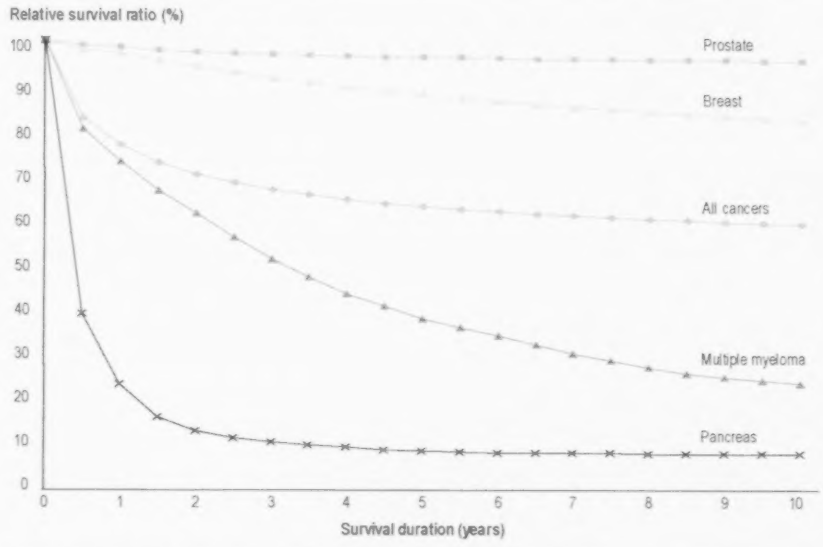
From 1992-1994 to 2004-2006, five-year relative survival for a number of cancers increased—usually slightly, but in some cases, appreciably (Figure 2). For example, the age-standardized RSR for non-Hodgkin lymphoma rose from 51% to 63%; that for leukemia, from 44% to 54%; and for liver, from 9% to 17%. For other cancers, age-standardized RSRs were stable (bladder, corpus uteri and pancreas) during the period. Increases in RSRs over time may reflect diagnosis at an earlier stage of the disease—when treatment is more effective or from which point survival is artefactually longer—or improvements in treatment.

Conclusion

Survival from cancer depends on the type of cancer and the age at diagnosis. Generally, relative survival is greater when cancer is diagnosed in early rather than later adulthood, but for some of the most common cancers, survival is less affected by age. The data suggest that since 1992-1994, the prognosis after diagnosis has generally improved somewhat—and notably so for a few cancers.

Statistics derived from an entire population's cancer survival experience provide a useful indicator of the disease's

Figure 1
Ten-year cumulative relative survival ratios, selected cancers, Canada excluding Quebec, 2004 to 2006



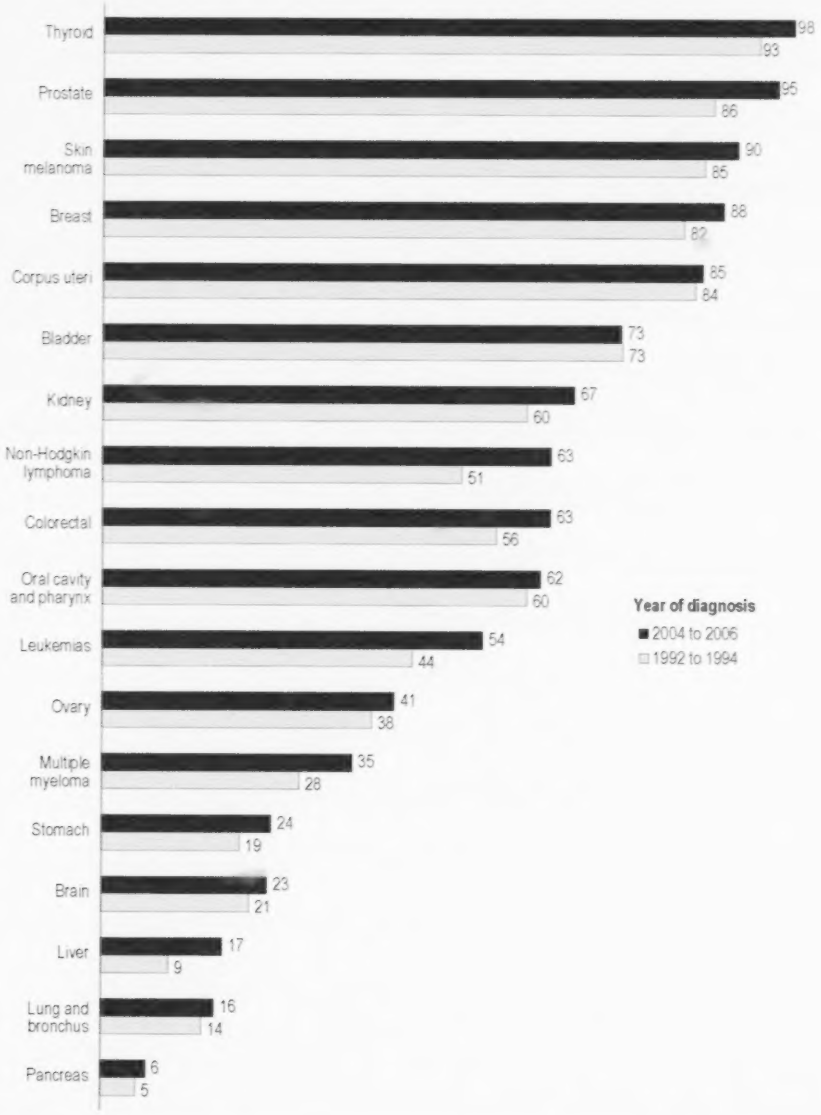
Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

Table 2
Predicted five-year relative survival ratios (RSR), by type of cancer and age group, population aged 15 to 99 at diagnosis, Canada excluding Quebec, 2004 to 2006

	Age group (years)														
	15 to 44			45 to 54			55 to 64			65 to 74			75 to 99		
	RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval	
Type of cancer	%	from	to	%	from	to	%	from	to	%	from	to	%	from	to
All cancers	**81**	**81**	**82**	**71**	**71**	**72**	**67**	**67**	**68**	**61**	**61**	**62**	**49**	**49**	**49**
Oral cavity and pharynx	82	79	84	71	68	73	62	60	65	56	53	58	53	50	57
Esophagus	18	12	26	16	12	20	16	13	18	14	12	16	10	8	12
Stomach	35	30	40	28	24	31	28	25	31	26	24	28	18	17	20
Colorectal	67	64	69	65	64	67	68	66	69	65	64	66	58	57	60
Liver	40	32	48	29	25	34	19	16	23	14	12	17	8	6	11
Pancreas	23	18	29	11	9	14	8	7	10	5	4	6	4	3	5
Larynx	82	70	90	70	64	75	66	62	69	60	56	64	63	57	69
Lung and bronchus	28	25	31	20	19	22	19	18	19	16	15	17	11	11	12
Skin melanoma	93	92	94	92	90	93	90	88	91	87	85	89	85	82	88
Breast	87	86	88	89	89	90	90	89	90	90	89	91	82	80	83
Cervix uteri	84	82	86	71	68	74	69	65	74	57	51	62	42	36	49
Corpus uteri	89	87	92	92	91	94	89	88	90	82	80	84	76	73	79
Ovary	73	70	76	57	54	60	44	41	46	32	30	35	20	18	23
Prostate	94	89	97	96	95	97	98	98	98	99	98	99	90	89	91
Testis	96	95	97	95	91	97	91	80	97	-	-	-	-	-	-
Bladder (including *in situ*)	87	83	91	82	79	84	80	79	82	76	74	78	64	62	66
Kidney and renal pelvis	85	82	87	75	73	77	71	69	73	65	63	67	54	51	56
Brain	58	55	61	27	24	31	13	11	15	9	7	11	4	2	5
Thyroid	100	99	100	99	98	100	98	96	99	94	91	97	86	79	92
Hodgkin lymphoma	95	93	96	86	81	90	81	74	87	57	48	65	41	31	51
Non-Hodgkin lymphoma	78	76	80	76	74	78	72	70	73	59	57	61	45	43	47
Multiple myeloma	64	55	71	61	56	65	50	46	53	34	31	37	21	19	24
Leukemias	68	65	70	71	68	74	66	64	69	55	52	57	38	36	40

- standard error >0.05
Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries

Figure 2
Age-standardized five-year relative survival ratios for cases diagnosed in 1992 to 1994 and in 2004 to 2006, by type of cancer, population aged 15 to 99, Canada excluding Quebec



Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

burden. These estimates reflect the average survival time of large groups of people and do not necessarily reflect an individual's chances of surviving for a given period. The prognosis for a specific person diagnosed with cancer will take into account individual factors that may affect survival such as frailty, co-morbidity, stage of disease at detection, treatment modality, and response to treatment. Nonetheless, the data provide excellent information on the impact of various types of cancer following diagnosis. ■

Acknowledgement

The Canadian Cancer Registry is maintained by Statistics Canada. It is comprised of data supplied by the provincial and territorial cancer registries whose cooperation is gratefully acknowledged.

References

1. Statistics Canada 2009. *Cancer Survival Statistics* (Statistics Canada, Catalogue 82-226-XIE-2009001) Ottawa: Minister of Industry, 2009. Available at: http://www.statcan.gc.ca/pub/82-226-x/82-226-x2009001-eng.htm.
2. Parkin DM, Chen VW, Ferlay J, et al. *Comparability and Quality Control in Cancer Registration* (IARC Technical Publication No. 19) Lyon: International Agency for Research on Cancer, 1994.
3. Fritz A, Percy C, Jack A, et al., eds. *International Classification of Diseases for Oncology, Third Edition*. Geneva: World Health Organization, 2000.
4. Horner MJ, Ries LAG, Krapcho M, et al., eds. *SEER Cancer Statistics Review, 1975-2006*. Bethesda, Maryland: National Cancer Institute. Based on November 2008 SEER data submission, posted to SEER website, 2009. Available at: http://seer.cancer.gov/csr/1975_2006/.
5. Brenner H, Hakulinen T. Patients with previous cancer should not be excluded in international comparative cancer survival studies. *International Journal of Cancer* 2007; 121: 2274-8.
6. Rosso S, De Angelis R, Ciccolallo L, et al. Multiple tumours in survival estimates. *European Journal of Cancer* 2009; 45: 1080-94.
7. Ellison LF. Measuring the effect of including multiple cancers in survival analyses using data from the Canadian Cancer Registry. *Cancer Epidemiology* (2010), doi:10.1016/j.canep.2010.06.015.
8. Ederer F, Axtell LM, Cutler SJ. The relative survival rate: a statistical methodology. *National Cancer Institute Monographs* 1961; 6: 101-21.
9. Dickman PW. *Population-based Cancer Survival Analysis*. Available at: http://www.pauldickman.com/rsmodel/sas_colon/. Accessed January, 2010.
10. Ederer F, Heise H. The effect of eliminating deaths from cancer on general population survival rates, methodological note 11, End Results Evaluation section, National Cancer Institute, August 1959.
11. Brenner H, Gefeller O. An alternative approach to monitoring cancer patient survival. *Cancer* 1996; 78: 2004-10.
12. Brenner H, Gefeller O. Deriving more up-to-date estimates of long term patient survival. *Journal of Clinical Epidemiology* 1997; 50: 211-6.
13. Brenner H, Söderman B, Hakulinen T. Use of period analysis for providing more up-to-date estimates of long term survival rates: empirical evaluation among 370,000 cancer patients in Finland. *International Journal of Epidemiology* 2002; 31: 456-62.
14. Brenner H, Gefeller O, Hakulinen T. Period analysis for "up-to-date" cancer survival data: theory, empirical evaluation, computational realisation and applications. *European Journal of Cancer* 2004; 40: 326-35.
15. Talbäck M, Stenbeck M, Rosén, M. Up-to-date long term survival of cancer patients: an evaluation of period analysis on Swedish Cancer Registry data. *European Journal of Cancer* 2004; 40: 1361-72.
16. Ellison LF. An empirical evaluation of period survival analysis using data from the Canadian Cancer Registry. *Annals of Epidemiology* 2006; 16(3): 191-6.
17. Ellison LF, De P, Mery LS, Grundy PE. Canadian cancer statistics at a glance: cancer in children. *Canadian Medical Association Journal* 2009; 180: 422-4.
18. Ellison LF, Pogany L, Mery LS. Childhood and adolescent cancer survival: a period analysis of data from the Canadian Cancer Registry. *European Journal of Cancer* 2007; 43: 1967-75.
19. Ellison LF, Gibbons L. Survival from cancer – up-to-date predictions using period analysis. *Health Reports* (Statistics Canada, Catalogue 82-003) 2006; 17(2): 19-30.
20. Canadian Cancer Society's Steering Committee: *Canadian Cancer Statistics 2009*. Toronto: Canadian Cancer Society, 2009.